

PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES
FOURTH SERIES

Vol. XVI, No. 19, pp. 605-647, plates 17-21 SEPTEMBER 2, 1927



XIX
PALEONTOLOGY OF THE
MIOCENE OF LOWER CALIFORNIA

BY
LEO GEORGE HERTLEIN AND ERIC KNIGHT JORDAN
Department of Paleontology

CONTENTS

	PAGE
Introduction	606
List of Miocene Species.....	607
Localities and Faunal lists.....	609
Correlation	613
Notes and Descriptions of Species.....	619

September 2, 1927

INTRODUCTION

This paper is a report on the available collections of fossils from the Miocene beds of Lower California, of which no extensive list has heretofore been published, and the fauna herein described extends our knowledge of the Miocene of western North America southward.

The greater part of the material upon which the report is based was collected by geologists of the Marland Oil Company chiefly in the regions of La Purisima and San Ignacio Lower California. Most of the material was deposited at Leland Stanford Junior University by Mr. Carl H. Beal, Chief Geologist of the company, through whose courtesy and that of Dr. J. P. Smith of the University, it has been available for the present study. A few specimens in the University collection were obtained by Mr. E. Call Brown in Lower California, and these have also been available for study. Pertinent collections of the California Academy of Sciences have also been considered.

A few species have heretofore been described or listed from the Miocene of Lower California. Gabb¹ referred to *Ostrea titan* Conrad in 1868 and 1869². A few species have been listed by Dickerson³, Arnold and Clark⁴, Darton⁵, and Heim⁶. Kew⁷ described one species thought to be of Miocene age from Lower California. Hertlein⁸ in 1925 described or listed the pectens in the collections made by the geologists of the Marland Oil Company. The geologic occurrence of the Miocene beds at various places in Lower California has been discussed by Wittich⁹, Heim¹⁰, geologists of the Marland Oil Company¹¹, and Jordan and Hertlein¹².

¹ Browne, J. Ross, Mineral Resources of the Pacific Coast west of the Rocky Mountains 1868, pp. 632-633; see also Petermann's Geograph. Mittheilungen, Bd. 14, 1868, pp. 273-276.

² Resources of the Pacific Slope, 1869, pp. 114, 633.

³ Proc. Calif. Acad. Sci., 4th Ser., Vol. 7, No. 8, 1917, p. 202.

⁴ Bull. Geol. Soc. Amer., Vol. 28, 1917, p. 223.

⁵ Jour. Geol., Vol. 29, No. 8, 1921, pp. 731-741.

⁶ Geol. Mag., Vol. 59, No. 702, 1922, p. 536.

⁷ Univ. Calif. Pub. Geol., Vol. 12, No. 2, 1920, p. 141.

⁸ Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, pp. 1-35.

⁹ Zeit. der Deutschen Geol. Gesellschaft. Monatsber. Nr. 12, 1911, pp. 575, 581, 583.

¹⁰ Zeit. für Vulkanologie herausgegeben von Imm. Friedlander, Bd. 6, 1921, pl. 4; Geol. Mag., Vol. 59, No. 702, 1922, pp. 536-541.

¹¹ Bol. del Petroleo, Vol. 18, No. 1, 1924, pp. 51, 52, map opp. p. 52.

¹² Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 14, 1926, pp. 413, 414.

In the present paper a general list of the Miocene fossils is given, followed by each separate locality with its respective faunal list. The relations of the present fauna to Miocene faunas elsewhere are considered. Notes on certain species are given and sixteen new species are described.

The writers wish to acknowledge the help received from Dr. G. Dallas Hanna, Curator of Paleontology in the California Academy of Sciences, for advise and assistance in various ways during the preparation of the manuscript; Mr. Carl H. Beal of the Marland Oil Company of California, for permission to publish upon collections made by geologists of that company. They also wish to thank Dr. J. P. Smith of Leland Stanford Junior University for permission to study these collections and for helpful suggestions and criticism during the study; Mrs. I. S. Oldroyd for permission to study specimens in the Conchological Museum of Leland Stanford Junior University, and Dr. B. L. Clark for permission to examine type specimens in the University of California. The greater part of this material is now in the Paleontological collections of the Leland Stanford Junior University; paratypes where available and plastotypes are in the collections of the California Academy of Sciences.

LIST OF MIOCENE SPECIES

Echinoidea

1. *Scutella norrisi* Pack, Loc. 66 (L.S.J.U.). Fragments Loc. 58 (L.S.J.U.).
2. *Clypeaster* aff. *deserti* Kew? Loc. 67 (L.S.J.U.).

Pelecypoda

3. *Amiantis* cf. *communis* Nomland, Loc. 66 (L.S.J.U.).
4. *Arca* sp., Loc. 58 (L.S.J.U.).
5. *Cardium* cf. *quadrigenarium* Conrad (cast.), Loc. 73 (L.S.J.U.).
6. *Cardium* sp., Loc. 58 (L.S.J.U.).
7. *Chione richthofeni* Hertlein & E. K. Jordan, new species, Loc. 66 (L.S.J.U.).
8. *Chione* aff. *temblorensis* Anderson, Loc. 60 (L.S.J.U.).
9. *Chione* sp., Loc. 72 (L.S.J.U.).
10. *Codakia* sp., Loc. 72 (L.S.J.U.).
11. *Glycymeris* sp., Loc. 58 (L.S.J.U.).
12. *Glycymeris* sp., Loc. 72 (L.S.J.U.).

13. *Glycymeris swartsi* Hertlein & E. K. Jordan, new species, Loc. 60 (L.S.J.U.).
14. *Metis alta* Conrad, Loc. 66 (L.S.J.U.).
15. *Mytilus* cf. *mathewsonii* Gabb, Loc. 66 (L.S.J.U.).
16. *Ostrea angermannii* Hertlein & E. K. Jordan, new species, Loc. 59 (L.S.J.U.).
17. *Ostrea eldridgei* Arnold, Loc. 147 (L.S.J.U.).
18. *Ostrea freudenbergi* Hertlein & E. K. Jordan, new species, Loc. 59 (L.S.J.U.).
19. *Ostrea* sp., Loc. 59 (L.S.J.U.).
20. *Ostrea* sp., Locs. 57, 71 (L.S.J.U.).
21. *Pecten (Leptopecten) andersoni* Arnold, Locs. 958, 960 (C.A.S.).
22. *Pecten (Lyropecten) crasscardo* Conrad, Loc. 57 (L.S.J.U.).
23. *Pecten (Plagiectenium) diminutivus* Hertlein & E. K. Jordan, new species, Loc. 60 (L.S.J.U.).
24. *Pecten (Lyropecten) pretiosus* Hertlein, Loc. 57 (L.S.J.U.).
25. *Sanguinolaria toulai* Hertlein & E. K. Jordan, new species, Loc. 66 (L.S.J.U.).
26. *Saxidomus* cf. *vaquerosensis* Arnold, Loc. 66 (L.S.J.U.).

Gastropoda

27. *Calliostoma hannibali* Hertlein & E. K. Jordan, new species, Loc. 66 (L.S.J.U.).
28. *Calyptrea inornata* Gabb, Loc. 66 (L.S.J.U.).
29. *Calyptrea costellata* Conrad, Loc. 57 (L.S.J.U.).
30. *Crassispira starri* Hertlein & E. K. Jordan, new species, Loc. 66 (L.S.J.U.).
31. *Cymia heimi* Hertlein & E. K. Jordan, new species, Loc. 66 (L.S.J.U.).
32. *Cypraea amandusi* Hertlein & E. K. Jordan, new species, Loc. 66 (L.S.J.U.).
33. *Forreria* sp., Loc. 60 (L.S.J.U.).
34. *Macron hartmanni* Hertlein & E. K. Jordan, new species, Loc. 66 (L.S.J.U.).
35. *Polinices reclusianus* (Deshayes), Loc. 66 (L.S.J.U.).
36. *Rapana imperialis* Hertlein & E. K. Jordan, new species, Loc. 57 (L.S.J.U.).
37. *Terebra burckhardtii* Hertlein & E. K. Jordan, new species, Loc. 66 (L.S.J.U.).
38. *Thais wittichi* Hertlein & E. K. Jordan, new species, Loc. 66 (L.S.J.U.).
39. *Turritella* sp. Loc. 57 (L.S.J.U.).
40. *Turritella* sp., Loc. 60 (L.S.J.U.).
41. *Turritella bösei* Hertlein & E. K. Jordan, new species, Loc. 66 (L.S.J.U.).
42. *Turritella ocoyana* Conrad, Loc. 60; 66 (L.S.J.U.).
43. *Turritella* cf. *ocoyana* Conrad, Loc. 59; 74 (L.S.J.U.).
44. *Turritella wittichi* Hertlein & E. K. Jordan, new species, Loc. 59 (L.S.J.U.).

Cirripedia

45. *Balanus* aff. *B. t. californicus* Pilsbry, Loc. 66 (L.S.J.U.).
46. *Balanus* sp., Loc. 68 (L.S.J.U.).
47. *Balanus* sp., Loc. 58 (L.S.J.U.).

Sharks Teeth

48. *Aetobatus smithii* Jordan & Beal, Loc. 945 (C.A.S.).
49. *Carcharocles rectus* Agassiz, Loc. 945 (C.A.S.).
50. *Carcharinus antiquus* Agassiz, Loc. 945 (C.A.S.).
51. *Carcharodon* sp., Loc. 945 (C.A.S.).
52. *Hemipristis heteropleurus* Agassiz, Locs. 958, 960 (C.A.S.).
53. *Isurus hastalis* Agassiz, Loc. 958 (C.A.S.).

LOCALITIES AND FAUNAL LISTS

Loc. 57 (L.S.J.U.). La Purisima cliffs, San Ramon River, Lower California; E. Call Brown collector.

Ostrea sp.

Pecten (*Lyropecten*) *crassicardo* Conrad.

Pecten (*Lyropecten*) *pretiosus* Hertlein.

Calyptrea costellata Conrad.

Rapana imperialis Hertlein & E. K. Jordan, new species.

Turritella sp.

The fossils from this locality show excellent preservation. They occur in the fine grained white sandstone of the Isidro(?) formation which is lower Miocene in age.

Loc. 58 (L.S.J.U.). White beds at top of cliff 2 kilometers above San Angel, Lower California. B. F. Hake and W. P. L. Winham collectors.

Arca sp.

Cardium sp.

Glycymeris sp.

Scutella sp. (fragments).

Balanus sp.

The casts of the mollusks listed and the lithology indicate lower Miocene age.

Loc. 59 (L.S.J.U.). *Turritella* bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower Cali-

fornia, on the trail from Arroyo Mesquital to La Purisima, Lower California. E. Call Brown collector.

Ostrea angermanni Hertlein & E. K. Jordan, new species.

Ostrea freudenbergi Hertlein & E. K. Jordan, new species.

Ostrea sp.

Ostrea sp.

Pecten (*Lyropecten*) *pretiosus* Hertlein.

Turritella ocoyana Conrad.

Turritella wittichi Hertlein & E. K. Jordan, new species.

This assemblage indicates Temblor, lower Miocene age. The lithology is apparently the same as that of the Isidro formation.

Loc. 60 (L.S.J.U.). West side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California; lower Miocene; B. F. Hake collector.

Chione aff. *temblorensis* Anderson.

Glycymeris swartsi Hertlein & E. K. Jordan, new species.

Pecten (*Plagioctenium*) *diminutivus* Hertlein & E. K. Jordan, new species.

Forreria sp.

Turritella sp.

Turritella ocoyana Conrad.

The matrix is a fine grained gray sandstone. Isidro(?) formation. The mollusks indicate Temblor, lower Miocene age.

Loc. 66 (L.S.J.U.). Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; Isidro formation, lower Miocene; B. F. Hake collector.

Amiantis cf. *communis* Nomland.

Chione richthofeni Hertlein & E. K. Jordan, new species.

Metis alta Conrad.

Mytilus cf. *matthewsonii* Gabb.

Sanguinolaria toulai Hertlein & E. K. Jordan, new species.

Saxidomus cf. *vaquerosensis* Arnold.

Calliostoma hannibali Hertlein & E. K. Jordan, new species.

Calyptrea inornata Gabb.

Cymia heimi Hertlein & E. K. Jordan, new species.

Cypraea amandusi Hertlein & E. K. Jordan, new species.

Crassispira starri Hertlin & E. K. Jordan, new species.

Macron hartmanni Hertlein & E. K. Jordan, new species.

Polinices reclusianus (Deshayes).

Terebra burckhardtii Hertlein & E. K. Jordan, new species.

Thais wittichi Hertlein & E. K. Jordan, new species.

Turritella bösei Hertlein & E. K. Jordan, new species.

Turritella ocoyana Conrad.

Scutella norrisi Pack.

Balanus aff. *B. t. californicus* Pilsbry.

This fauna shows excellent preservation and occurs in a light colored fine grained sandstone. Isidro formation. The fauna is apparently of lower Miocene age, certainly as old as the Temblor of California and possibly equivalent in part to the upper Vaqueros of California. The general assemblage indicates a lower Temblor age.

Loc. 67 (L.S.J.U.). Arroyo Lievre, between Ranchito San Bartolo and where Camino Real from San Luis to La Paz crosses. In beds above white shale. Probably Isidro formation. W. S. W. Kew collector.

Clypeaster aff. *deserti* Kew.

The species in the present collection seems most closely related to Kew's species. The preservation of the echinoderm as well as the lithological character of the matrix is typical of the Isidro, lower Miocene.

Loc. 68 (L.S.J.U.) Miocene. San Juan, Lower California, near San Ignacio. B. F. Hake collector.

Balanus sp.

Loc. 71 (L.S.J.U.). Cliff around San Ignacio, Lower California; probably Isidro; B. F. Hake collector.

Ostrca sp.

Loc. 72 (L.S.J.U.). 24 kilometers southwest of San Ignacio; just above San Angel, San Lorenzo Quadrangle, Lower California; lowest Miocene beds(?); B. F. Hake and W. P. L. Winham collectors, 1921.

Chione sp.

Codakia sp.

Glycymeris sp.

Loc. 73 (L.S.J.U.). 3.1 kilometers southwest of Loc. 72 (L.S.J.U.); lowest Miocene beds, San Lorenzo Quadrangle, Lower California. W. P. L. Winham collector, 1921.

Cardium cf. *quadrigenarium* Conrad. (Cast).

Loc. 74 (L.S.J.C.). 1 kilometer southwest of Loc. 72 (L.S.J.U.); 2 kilometers N. 80° west of San Angel, Lower California; lower Miocene; W. P. L. Winham collector, 1921.

Turritella cf. *ocoyana* Conrad.

This species also occurs in the Temblor lower Miocene of California where it is very common.

Loc. 101 (L.S.J.U.). Diatomite from the Rancho San Gregorio; (lower Miocene of Marland Oil Company geologists); C. R. Swarts collector.

Loc. 147 (L.S.J.U.). Arroyo Mesquital, 18 miles north of La Purisima, Lower California. Miocene. E. Call Brown collector.

Ostrea eldridgei Arnold.

This species has previously been known only in the Temblor and Vaqueros, lower Miocene formations of California.

Loc. 945 (C.A.S.). Turtle Bay, Lower California. Miocene beds from one to two miles to southeast of bay. G. Dallas Hanna and E. K. Jordan collectors, 1925.

Aetobatus smithii Jordan & Beal.

Carcharocles rectus Agassiz.

Carcharinus antiquus Agassiz.

Carcharodon sp.

These species also occur in the beds of Temblor age in California.

Loc. 958 (C.A.S.). Miocene beds on east side of Turtle Bay, Lower California, about one-half mile northeast of prominent yellow mesa or monadnock. From thin bed just above contact with older Eocene(?) conglomerates. E. K. Jordan and G. D. Hanna collectors, 1925.

Pecten (Leptopecten) andersoni Arnold.

Hemipristis heteropleurus Agassiz.

Isurus hastalis Agassiz.

These are typical Temblor species of the California Miocene.

Loc. 960 (C.A.S.). Miocene beds in large cañon one mile north of north end of Turtle Bay, Lower California. From base of section close to contact with Eocene(?) conglomerates. G. D. Hanna and E. K. Jordan collectors, 1925.

Pecten (Leptopecten) andersoni Arnold.

Hemipristis heteropleurus Agassiz.

These beds are apparently equivalent to those at Loc. 958 (C.A.S.).

CORRELATION

Beds in the Cape Region of Lower California which were thought to be of Miocene age were reported from northeast of Santiago by Gabb¹³ in 1868 and 1869. These were assigned to the Miocene because of the presence in them of a large oyster, thought to be *Ostrea titan* Conrad. Fuchs¹⁴ in 1886 and Saladin^{14a} in 1892 referred to beds which they thought might be Miocene or Pliocene in age near Boleo, Lower California, but all the collections from there as well as the species reported from that region¹⁵ indicate an upper Pliocene¹⁶ age.

Aguilera¹⁷ in 1896 referred to beds of "Mioceno Superior á Plioceno" age in the southern part of Lower California. Whether this referred to beds of Miocene age or to beds now known to be Pliocene cannot be determined.

Aguilera¹⁸ in 1906 referred to beds of upper Miocene age at Santa Rosalia and Boleo, Lower California; these, how-

¹³ Browne, J. Ross. Mineral Resources of the Pacific Coast west of the Rocky Mountains 1868, pp. 632-633; Resources of the Pacific Slope, 1869, p. 114, 633.

¹⁴ Bull. Geol. Soc. France (3), T. 14, 1885 (1886), p. 82.

^{14a} Bull. Soc. l'Ind. Min., 3rd Ser., Vol. 6, 1892, p. 10.

¹⁵ Arnold, R., U. S. Geol. Surv. Prof. Paper 47, 1906, p. 85.

¹⁶ G. D. Hanna and L. G. Hertlein, Proc. Calif. Acad. Sci., 4th Ser., Vol. 16, No. 6, 1927.

¹⁷ Inst. Geol. Mex. Bol., Nos. 4-6, 1896 (1897), p. 227.

¹⁸ Cong. Geol. International, Vol. 10 (pt. 1), 1906, p. 244.



ever, are now known to be Pliocene in age. Wittich¹⁹ in 1909 and 1911 writing on the Geology of the Cape Region described Miocene beds which he thought lay upon granite and were overlain conformably by Pliocene sediments. These lower beds he thought might be Pliocene in age but stated that they had been considered to be of Miocene age by American geologists. Heim²⁰ in 1915 described beds of Miocene age in the southern part of Lower California in La Purisima valley. The diatomaceous beds in the Miocene series were referred to the Monterey shale and were reported to be of the same lithologic character as the Monterey shale of California. Dicker-son²¹ in 1917 listed Miocene species from Lower California which were later referred to by Arnold and Clark, and by Heim. These species were thought to represent a fauna equivalent to the Bowden Miocene of the Caribbean region and thus to indicate a direct connection with the Caribbean Sea during Bowden Miocene time.

J. P. Smith²² in 1919 referred to a Miocene fauna probably of Vaqueros age from near San Gregorio Lagoon on the Pacific coast of Lower California. Arnold and Clark²³ in 1917 briefly discussed a Miocene collection made by Dr. Heim. The fossils were referred to the Apalachicola horizon of the Caribbean Sea region. Kew²⁴ in 1920 described *Cassidulus (Rhynchopygus) mexicanus* from East San Ysidro, Lower California. He stated that the horizon was probably equivalent to the Gatun formation of the Gulf-coastal Plain and referred it questionably to the lower Pliocene. Heim²⁵ in 1921 showed on a map three Miocene divisions in the region of La Purisima, Lower California. He mapped the Purisima Nueva formation as questionably Oligocene. In the Miocene he mapped Monterey shale, "grüne Molasse, Sandstein" and "braune Molasse, Konglomerat." Freudenberg²⁶ in 1921 referred to the Mio-

¹⁹ Bol. Soc. Geol. Mex., Vol. 6, pt. 1, 1909, p. 8; Zeit. der Deutschen Geol. Gesellschaft Monatsber., Nr. 12, 1911, pp. 575, 581, 583, pl. 1.

²⁰ Comptes Rendus. Ac. d. Sc. Paris, t. 161, 1915, p. 420.

²¹ Proc. Calif. Acad. Sci., 4th Ser., Vol. 7, No. 8, 1917, p. 197-205; Bull. Geol. Soc. Amer., Vol. 28, 1917, pp. 230-232.

²² Proc. Calif. Acad. Sci., 4th Ser., Vol. 9, No. 4, 1919, p. 161.

²³ Bull. Geol. Soc. Amer., Vol. 28, 1917, p. 223.

²⁴ Univ. Calif. Pub. Geol., Vol. 12, No. 2, 1920, p. 141.

²⁵ Zeit. für Vulkanologie herausgegeben von Imm. Friedlander, Bd. 6, 1921, map pl. 4.

²⁶ Geologie von Mexiko, Berlin, 1921, p. 133.

cene beds described by Heim. Darton²⁷ in 1921 described Miocene beds in the region of La Purisima and San Ignacio, Lower California. He recognized "Monterey beds" with a thickness of 500 feet and "yellow beds" with a thickness of about 500 feet. He listed fossils which are characteristic of the Miocene of California such as *Pecten crassicardo* Conrad and *Turritella ocoyana* Conrad. Darton tentatively correlated the Monterey beds with the Monterey formation of southern California, and the yellow beds were considered on the basis of fossils to belong to the late Miocene.

Wilhelm²⁸ in 1921 discussed beds around Miraflores and San Bartoleo on the east side of the southern part of Lower California. These beds contained large oysters and were considered to be Miocene in age. The beds were said to be about 1,000 feet in thickness and made up of fine grained sandstone, clay shales and sundry limestone beds containing the species of large oysters. These strata, he stated, conformably overlie upper Cretaceous strata and are overlain apparently conformably by Pleistocene.

Bustamente²⁹ the same year referred to beds in the southern part of lower California as the "grupo de La Purisima" which were thought to be Miocene-Pliocene in age; he stated, however, that he was of the opinion that no Miocene was present there, although regarding this point he was not certain. At one locality, strata said to contain tripoli or chalk were referred to as the "grupo de San Ramón-Paso Blanco" and were considered to be of Eocene age. Heim³⁰ in 1922 discussed the Miocene of Lower California and gave additional information concerning the different formations. He stated that the opinion is held by some American geologists that the "Purisima Nueva formation" and the Isidro formation are identical. He, however, was inclined to regard them as separate formations. The report of Arnold and Clark was based upon fossils from the Purisima Nueva formation. The name Monterey formation was used for diatomaceous shales overlying the Purisima Nueva formation. Heim thought an unconformity was present between the two formations but stated that all

²⁷ Jour. Geol., Vol. 29, No. 8, 1921, p. 731-741.

²⁸ Min. & Sci., Press. Vol. 123, No. 4, 1921, pp. 125-127.

²⁹ Bol. del Petroleo, Vol 11, No. 6, 1921, pp. 504-511.

³⁰ Geol. Mag., Vol. 59, No. 702, 1922, pp. 536-541.

geologists do not agree with him on this point. The name Isidro formation was used for shale and shaly sandstone (Grüne molasse of Heim 1921) overlying the Monterey shale and into which the Monterey grades upward. The Isidro formation according to Heim is at some places conformably and at others unconformably overlain by the Comundu (Braune molasse of Heim 1921) Pliocene formation and by Quaternary conglomerates.

Jordan and Hannibal³¹ in a paper describing shark teeth in 1923 listed localities of Monterey Miocene age in Lower California.

In a paper compiled from the results of the Marland Oil Company³², published in 1924, the Miocene was mapped under two formations, a diatomaceous, San Gregorio formation and the overlying Isidro formation which has a sandy composition. They also stated that the Isidro shale in the Magdalena Bay region is equivalent to the San Gregorio shale in the Purisima region.

Hertlein³³ in 1925, referring to the work of Heim and of Beal, also listed and described pectens, some of which were recognized as belonging to the Miocene.

Hanna³⁴ in 1926 referred to beds of Miocene age at Turtle Bay and thought that the basal Miocene beds there containing shark teeth, sea lion teeth and pectens could be correlated with similar Miocene beds in Kern County, California.

Jordan and Hertlein³⁵ in 1926 described Miocene beds at Turtle Bay which are several hundred feet thick. The base of the Miocene is a layer containing bones and sharks' teeth. The bone bed is overlain by a bed of white siliceous shale about 30 feet thick. The remainder of the series was said to be made up of soft, fine grained sandstone, ash, and impure diatomite rich in fish scales and in casts of foraminifera. The beds were reported as dipping in a general westerly direction about 20°. The Miocene series is overlain unconformably by Pliocene beds. The beds at Turtle Bay were considered to be equivalent to similar beds on Cedros Island.

³¹ Bull. Southern Calif. Acad. Sci., Vol. 22, pt. 2, 1923, pp. 54, 60.

³² Bol. del Petroleo, Vol. 18, No. 1, 1924, pp. 51, 52, map opp. p. 52.

³³ Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, pp. 1-35.

³⁴ Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 1, 1926, p. 85.

³⁵ Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 14, 1926, p. 414.

Apparently the strata at the various localities do not differ greatly in age and for the present are considered to be approximately equivalent. The sediment in which the fossils occur is for the most part whitish, medium fine grained sandstone; the sediment as well as the fauna seems to indicate a neritic facies of marine deposition. Correlation³⁶ of these beds with other deposits is made chiefly on community of diagnostic species and on the presence of certain groups.

The present fauna shows but little affinity with the Miocene fauna of western South America, but it does contain certain forms which show close relationship with the Caribbean Miocene fauna. This is shown by such species as *Cymia heimi*, and *Cypraea amandusi*, but in no case in the present collection can the species be definitely identified with those of the Caribbean region. On the other hand the fauna is decidedly western North American in its affinities with about 50% of the identified species identical with those from Miocene formations of California, and it contains a number of other closely related species. Such species as *Ostrea eldredgei* Arnold, *Pecten andersoni* Arnold, *Pecten crassicardo* Conrad, *Calyptrea radians* Lamarck, *Turritella ocoyana* Conrad and *Isurus hastalis* Agassiz are very common and most of them confined to the lower Miocene of California. The evidence of a connection between the Pacific and Caribbean seas has been well shown by Dr. J. P. Smith³⁷ who pointed out that Caribbean groups such as *Lyropecten*, *Dosinia*, giant oysters and *Chione* of the *gnidia* group first appeared in the Miocene on the west coast. The present fauna also contains a few Oriental forms such as *Rapana*.

A preliminary examination of a sample of shale containing fossil diatoms from Loc. 101 (L.S.J.U.), diatomite from the Rancho San Gregorio, Lower California, has been made by Dr. G. Dallas Hanna. The forms found and their relationships are so important from a correlation standpoint that he hopes to prepare a separate report on the deposit in the near future. He states³⁸ that:

³⁶ For an excellent discussion of the principles of correlation see C. Diener, *Grundzüge der Biostratigraphie*, Wien, 1925, pp. 138-156.

³⁷ *Proc. Calif. Acad. Sci.*, 4th Ser., Vol. 9, No. 4, 1919, pp. 123-173.

³⁸ Written communication.

"The examination which has been made, indicates that the formation is lower Miocene in age and the flora is very different from that recently described from Maria Madre Island³⁹, upper Miocene, a few hundred miles to the southward. There were noted in the study of that material, certain resemblances to east coast Miocene deposits and this relationship was probably as close as it is to the Monterey shale of California, the diatoms of which have been very thoroughly studied and illustrated. The deposit from Loc. 101 (L.S.J.U.), diatomite from the Rancho San Gregorio, Lower California, appears to be very much more closely related to lower Miocene diatom-bearing shales of New Jersey, Maryland and Virginia. The resemblance amounts to identity of species in some noteworthy cases; and it is believed that a close study of the material will disclose numerous species found heretofore only in the east coast deposits mentioned. Certain others are found in lower Miocene deposits of other parts of the world but the resemblance appears to be less close than to those mentioned."

The writers consider the Miocene fauna discussed in the present paper to be lower Miocene in age and from the present collection the evidence indicates that the fauna is equivalent at least in part to that found in the lower part of the Temblor beds of California which occur in the Temblor basin and the Kern River district⁴⁰. Possibly they are in part equivalent to the upper Vaqueros^{40a}, but the assemblage as a whole indicates a lower Temblor, lower Miocene age.

Considered as to climatic relations the fauna is composed in great part of warm water types with *Chione*, *Lyropecten*, giant *Ostrea* and giant *Turritella* which are subtropical or tropical forms.

³⁹ See Hanna & Grant, Miocene Marine Diatoms from Maria Madre Island, Mexico, Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 2, April 1926, pp. 115-193, pls. 11-21.

⁴⁰ Proc. Calif. Acad. Sci., 4th Ser., Vol. 4, No. 3, 1914; Proc. Calif. Acad. Sci., 4th Ser., Vol. 3, 1911, pp. 73-148.

^{40a} By "Vaqueros" is meant the formation containing the fauna listed by J. P. Smith, Proc. Calif. Acad. Sci., 4th Ser., Vol. 9, No. 4, 1919, pp. 160-161.

NOTES AND DESCRIPTIONS OF SPECIES

1. *Chione richthofeni* Hertlein & E. K. Jordan, new species

Plate XVII, figures 4, 7, 8

Shell of medium size; subtrigonal; anteriorly concave in front of beaks; lunule large, cordate, striate and bounded by an impressed line; anterior and ventral margins of shell rounded; posterior ventral margin subrounded; posterior margin broadly curved; escutcheon long and narrow; beaks pointed forward; umbos high, well rounded and broadly rounded at their base; very slight flattening of valves bordering posterior margin; valves ornamented by fine even longitudinal sulcate ribs and concentric fringing lamellæ which are striate in line with ribs. Left valve (paratype) possesses two anterior and one posterior cardinal, behind the posterior cardinal two long raised ridges occur on the nymph plate. Length 49.8 mm.; height 46.5 mm.; thickness 40.9 mm.

Holotype and *paratype*: L.S.J.U. type collection, from Loc. 66 (L.S.J.U.); **Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California**; *paratypes* Nos. 2657 and 2658, Mus. Calif. Acad. Sci.; B. F. Hake collector. Isidro formation, lower Miocene.

Chione richthofeni differs from *Chione gnidia* Sowerby⁴¹ in possessing fine, even radial ribbing, the rounding of the umbos extends farther toward the posterior margin where the shell slopes rather abruptly to the slight flattening near the posterior margin; furthermore, the present species possesses two posterior cardinal teeth in the left valve.

From *Chione temblorensis* Anderson⁴², *C. richthofeni* differs in possessing a more rounded posterior ventral margin and in lacking almost completely the prominent flattening of the dorsal margin which is so pronounced in Anderson's species. The rounded posterior ventral margin, the very slight flattening of the dorsal margin of the valves as well as the

⁴¹ Thes. Conch., Vol. 2, 1855, p. 709, pl. 154, fig. 25.

⁴² Proc. Calif. Acad. Sci., 3rd Ser., Vol. 2, No. 2, 1905, p. 196, pl. 14, figs. 36, 37, 38.

fine, even, radial ribbing distinguish *Chione richthofeni* from *C. walli* Guppy⁴³ of the Caribbean Miocene.

Apparently the present species differs from *V. navidadis* Philippi⁴⁴ in that the beaks are not situated so markedly anterior nor is it elongated dorsally as is the case in the species described by Philippi.

This species is named in recognition of the pioneer work in west coast geology by Baron von Richthofen.

2. *Glycymeris swartsi* Hertlein & E. K. Jordan, new species

Plate XVII, figures 1, 2

Shell fairly large, obliquely ovate, rather strongly inflated; umbos high, subcentral, sculpture consisting of fine concentric lines of growth, and faint radial lines noticed on only a few unweathered parts of the shell and apparently developed mostly near base of shell; valves rounded in front, somewhat produced behind. Length approximately 40 mm.; height 38.2 mm.; width 29.8 mm.

Holotype: L.S.J.U. type collection, from Loc. 60 (L.S.J.U.) west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California; *paratype* No. 2659, Mus. Calif. Acad. Sci., B. F. Hake collector; Isidro(?) formation, lower Miocene.

This species is unlike any other west coast *Glycymeris*. A row of taxodont teeth is present in one of the paratypes. The shape and sculpture of the valves and the circular row of teeth lead the authors to place this species under the genus *Glycymeris* although the shape is not similar to most other western North American species of that genus.

This species is named for Mr. C. R. Swarts, geologist with the Marland Oil Company during their geological exploration work in Lower California.

⁴³ See Maury, Bull. Amer. Paleo., Vol. 10, No. 42, 1925, p. 311, pl. 28, figs. 2, 11, 15.

⁴⁴ Fos. Terciar, I, Cuartar, Chile, 1887, p. 120, pl. 14, fig. 4.

3. *Ostrea angermanni* Hertlein & E. K. Jordan, new species

Plate XVII, figures 3, 6

Right valve rather small, subquadrate in outline, moderately arched; an unornamented area covers beak and umbonal region, remainder of shell ornamented by 15 to 20 medium fine, well developed radial plications. Interior of valve moderately deep, sloping from margins of shell to point of greatest concavity at center; hinge shows narrow ligament pit running to anterior dorsal edge of shell; dorsal and parallel to this another longer, narrow pit follows posterior dorsal edge of shell; margins of shell marked with small crenulations. Height 46.2 mm.; length 38.9 mm.; greatest diameter of shell 13.1 mm.

Holotype: Right valve L.S.J.U. type collection from Loc. 59 (L.S.J.U.), *Turritella* bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California, on the trail from Arroyo Mesquital to La Purisima; E. Call Brown collector; Isidro(?) formation, lower Miocene.

Ostrea angermanni differs from *O. vespertina* Conrad⁴⁵ in possessing a different hinge in which the pits are narrow and run obliquely across hinge to anterior dorsal margin of shell; furthermore, the present species possesses many more and much finer radial plications on the exterior of the valve. From *Ostrea (Alectryonia) plicata* Chemnitz⁴⁶ and *O. edulis* Linnæus⁴⁷, *O. angermanni* can be distinguished by the more numerous and finer radial plications ornamenting the right valve. *O. angermanni* differs from *O. sellæformis* var. *thomasii* Conrad⁴⁸, in that the lower valve of the present species is more quadrate in outline, it is apparently more highly arched and is ornamented by finer ribs. This species is named for Dr. E. Angermann in recognition of his work in Lower California.

⁴⁵ Jour. Acad. Nat. Sci. Phila., 2d Ser., Vol. 2, 1854, p. 300; see also Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 14, p. 428.

⁴⁶ See Reeve, Conch. Icon., Vol. 18, 1871, *Ostrea*, pl. 27, figs. 68a, b, c, d.

⁴⁷ See Reeve, Conch. Icon., Vol. 18, 1870, *Ostrea*, pl. 5, figs. 8a, b, c, d, e, f.

⁴⁸ See Maryland Geol. Surv., Miocene, 1904, p. 380, pl. 100, figs. 5a, 5b.

4. *Ostrea eldridgei* Arnold

Ostrea eldridgei ARNOLD, Proc. U. S. Nat. Mus., Vol. 32, 1907, p. 528, pl. 42, figs. 2, 2a. "Elkin's ranch east of Grimes Canyon, near Fillmore," California.

Loc. 147 (L.S.J.U.), Arroyo Mesquital, Lower California.

This enormously thickened oyster is considered to be characteristic of the Vaqueros and Temblor lower Miocene formations of California.

5. *Ostrea freudenbergi* Hertlein & E. K. Jordan, new species

Plate XVII, figure 9; plate XVIII, figure 4

Shell elongate, thickness medium, right valve moderately arched, narrow at beak but widening ventrally, made up of flattish layers of shell material which is ornamented by faint, rather small radial plications. Interior of valve under beak possesses a ligament pit which is rather prominent, long, fairly broad and moderately impressed; concavity of shell moderately deep, just ventral to ligament pit but becoming flatter toward the ventral margin; ventral muscle scar fairly large, impressed and located on the anterior side of the shell about a third of the length of shell from the ventral margin. Height 88.5 mm.; length 61.1 mm.; greatest diameter 21.1 mm.

Holotype: Right valve (L.S.J.U. type collection), from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California, on the trail from Arroyo Mesquital to La Purisima; E. Call Brown collector; Isidro (?) formation, lower Miocene.

Ostrea freudenbergi can be distinguished from *O. chilensis* Philippi⁴⁹ and other west coast *Ostreas* by its only moderately high right valve, elongate shape, faint radial ornamentation, differently shaped ligament pit and long, narrow beaks.

This species is named for Dr. Wilhelm Freudenberg in recognition of his contributions to the knowledge of the geology of Mexico.

⁴⁹ Martini-Chemnitz Conch. Cab., 2nd ed., *Ostrea*, 1845, p. 74, pl. 13, figs. 7-8; also Dall, W. H., Proc. U. S. Nat. Mus., Vol. 37, 1910, p. 148, pl. 26, fig. 1.

6. *Ostrea* sp.

Plate XIX, figures 3, 6

Several left valves of an *Ostrea* were found at Locs. 57 and 71 (L.S.J.U.) which probably do not belong to *Ostrea freudenbergi* and could not be referred with certainty to any known *Ostrea*. The valves are long, narrow, fairly smooth, slightly curved and bear a distinct raised area under the beaks. Nearly all these left valves possess exteriorly a groove running from middle of the shell to the anterior ventral edge of the valve.

Plesiotype: Left valve (L.S.J.U. type collection), from Loc. 57 (L.S.J.U.), La Purisima cliffs, San Ramon River, Lower California; E. Call Brown collector; Isidro(?) formation, lower Miocene.

7. *Pecten* (*Lyropecten*) *crassicardo* (Conrad)

Pallium crassicardo CONRAD, Proc. Acad. Nat. Sci. Phila., 1856, p. 313, "Monterey Co., Calif."

Pecten (*Lyropecten*) *crassicardo* (CONRAD), ARNOLD, Prof. Paper U. S. Geol. Survey 47, 1906, p. 71, pl. 16, figs. 1, 1a; pl. 17, figs. 1, 1a, 1b; pl. 18, figs. 1, 2, 2a.

Loc. 57 (L.S.J.U.), La Purisima Cliffs, Lower California; 1 specimen.

This is the specimen recorded by Hertlein⁵⁰ as "*Pecten* (*Lyropecten*) near *crassicardo* (Conrad)." The specimen can be definitely identified with that species. It shows no affinities with the large east American *Lyropectens*, *P. jeffersonius* Say and *P. madisonius* Say⁵¹, other than those shown by typical specimens of *P. crassicardo* (Conrad).

8. *Pecten* (*Plagiectenium*) *diminutivus*

Hertlein & E. K. Jordan, new species

Pecten (*Plagiectenium*) *calli* HERTLEIN, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 16, pl. 4, figs. 5 and 7; "west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California;" not *Pecten calli* HERTLEIN, pl. 4, fig. 6, "first arroyo east of Santiago, Lower California."

⁵⁰ Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 2.

⁵¹ See Dall, Trans. Wag. Inst. Sci., Vol. 3, pt. 4, 1898, pp. 722-725.

Shell small, right valve fairly flat and ornamented by 16 flattish topped to broadly rounded ribs which are separated by flattish bottomed interspaces which are very slightly narrower than the ribs; right ear well developed with strong byssal notch. Left valve convex with fairly high and rather sharp umbo, and ornamented by 15 to 16 ribs. Altitude 8 mm.; longitude 8 mm.; thickness 2.1 mm.; apical angle, approximately 98° .

Holotype: No. 125 (L.S.J.U. type collection), from Loc. 60 (L.S.J.U.), west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California; B. F. Hake collector; Isidro formation, lower Miocene.

The writers⁵² have previously pointed out that the Miocene species figured by Hertlein cannot be referred to *Pecten calli* Hertlein. It is small and may possibly be the young form of some described species, but several specimens have been found, and it seems best to refer to them with a definite name; *Pecten (Plagioctenium) diminutivus* is proposed.

The species differs from other west coast *Plagioctenium*s in its small size and flattish right valve.

9. *Pecten (Lyropecten) pretiosus* Hertlein

Pecten (Lyropecten) pretiosus HERTLEIN, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 12, pl. 2, fig. 6; pl. 3, fig. 4. "Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California."

This species appears to be closely related to *P. condylomatus* Dall⁵³ but can not be definitely assigned to that species. It differs from specimens of the latter in the collections of the California Academy of Sciences in smaller size, the right valve is higher at the umbo and the ribs are lower, evenly rounded and ornamented by numerous fine striæ. The valves in *P. pretiosus* usually show but slight areas comparable to the strong constrictions often found in *P. condylomatus*.

⁵² Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 14, 1926, p. 436.

⁵³ Trans. Wag. Free Inst. Sci., Vol. 3, pt. 4, 1898, p. 729, pl. 34, figs. 14, 15.

10. *Sanguinolaria toulai* Hertlein & E. K. Jordan, new species

Plate XX, figure 2

Shell large, thin, fairly compressed, subovate, outline similar to *S. nuttallii* Conrad; ventral margin evenly rounded; beaks small, acute; nymph prominent; two prominent cardinal teeth in left valve; faint groove on anterior dorsal margin of left valve; valves elongated posteriorly, ornamented by concentric lines of growth. Length (extreme ends of shell missing) 91.5 mm.; height 74.2 mm.

Holotype: (L.S.J.U. type collection) from Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; B. F. Hake collector; Isidro formation, lower Miocene.

Sanguinolaria toulai is larger and rounder than *S. nuttallii* Conrad⁵⁴ and *S. orcutti* Dall⁵⁵. The right valve is more convex and less triangular at the beaks and both valves are apparently more nearly equally inflated than is the case in *S. nuttallii*. *S. toulai* appears to lack any marked concavity on the anterior dorsal margins or any subangular line running from the beaks to the posterior end of the shell.

This species is named for Dr. Franz Toula in recognition of his contribution to the knowledge of the Tertiary of the Panama region.

11. *Saxidomus* cf. *S. vaquerosensis* Arnold

Saxidomus vaquerosensis ARNOLD, Bull. U. S. Geol. Survey, 396, 1909, p. 56, pl. 7, fig. 7; "Turritella ocoyana bed, . . . 10 miles north of Coalinga," California.

Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; one specimen.

S. vaquerosensis Arnold has previously been found in the lower Miocene of California.

⁵⁴ Jour. Acad. Nat. Sci. Phila., Vol. 7, 1837, p. 230, pl. 17, fig. 6; also Oldroyd, Stanford Univ. Pub. Geol., Vol. 1, No. 1, 1925, p. 185, pl. 55, figs. 1 and 4.

⁵⁵ See Dall, W. H., Proc. U. S. Nat. Mus., Vol. 66, No. 2554, 1925, p. 26, pl. 12, figs. 1 and 2.

12. *Calliostoma hannibali* Hertlein & E. K. Jordan,
new species

Plate XXI, figures 8, 9

Shell small, rather thin, conical, imperforate; tip of spire missing, four and one-half whorls present in type specimen; whorls sloping and broadly rounded to near periphery where a small angular shoulder is present; from shoulder, whorls slope abruptly to base; body whorl rounded at periphery; near base whorls ornamented by a raised spiral line; on next to last whorl a raised spiral line occurs midway between suture and angular shoulder; whorls ornamented by numerous fine spiral lines which are strongest on base of body whorl. Height approximately 20.5 mm.; width of body whorl 12.5 mm.; apical angle approximately 83° .

Holotype: (L.S.J.U. type collection) from Loc. 66 (L.S.J.U.), in **San Ignacio Arroyo, 8 kilometers southwest of San Ignacio, Lower California**; B. F. Hake collector; Isidro formation, lower Miocene.

Calliostoma hannibali differs from *C. eximium* Reeve⁵⁶ in possessing a lower spire, whorls which are more sloping and which are rounded at the periphery, and in possessing finer spiral sculpture.

This species is named for Mr. Harold Hannibal in recognition of his contributions to the stratigraphy of western North America.

13. *Crassispira starri* Hertlein & E. K. Jordan, new species

Plate XXI, figure 7

Shell small, elongate conic, fairly solid; spire turreted, probably of six or seven whorls, the tip of the spire lost; whorls flattened, sharply shouldered near the summit, with a pronounced beaded sutural band; axial sculpture of about 21 strong, narrow, sharp, straight, slightly protractive ribs, which become very slightly enlarged on the shoulder, and end

⁵⁶ Proc. Zool. Soc., 1842, p. 185; Tryon Man. Conch., Vol. 10, 1888, pl. 41, fig. 28; Vol. 11, 1889, p. 366, pl. 65, figs. 84-86.

in prominent rounded beads on the sutural band; spiral sculpture nearly obliterated in type specimen, but apparently of many fine, impressed lines; base long, not inflated, sculptured by continuations of the axial ribs, and apparently by fine spiral lines; aperture elongate-ovate, produced anteriorly into a fairly long canal; inner and outer lip with a small sinus posteriorly. Length (of last three whorls and canal) 19 mm.; width 8.4 mm.

Holotype: L.S.J.U. type collection from Loc. 66 (L.S.J.U.), **Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California**; B. F. Hake collector; Isidro formation, lower Miocene.

The strongly beaded sutural band of this species is its most striking characteristic. It differs from *Drillia* (*Crassispira*) *bösci* Engerrand & Urbina⁵⁷ in possessing a very strong, beaded band, much more sharply shouldered whorls and very faint spiral sculpture. The present species appears to differ from *Pleurotoma* (*Drillia*) *dalli* Toulou⁵⁸ in that the whorls are more sharply shouldered at their summits and possess much finer spiral sculpture than is the case in the species described by Toulou.

This species is named for Dr. David Starr Jordan, Chancellor Emeritus of Leland Stanford Junior University.

14. *Cymia heimi* Hertlein & E. K. Jordan, new species

Plate XVIII, figure 5

Shell large, thick and heavy, rather elongate; spire of about five whorls appressed at the sutures, the sides roughly flat; sutures wavy; body whorl and next to last whorl ornamented at the periphery by a row of strong, rounded nodes which are not prolonged into axial ribs; about eight or nine of these nodes on the body whorl; nodes not appearing from beneath the sutures until the next to the last whorl, the early whorls bearing neither nodes nor axial ribs; spire and base ornamented by many unequal and unequally spaced rather fine

⁵⁷ Bol. Soc. Geol. Mex., T. 6, pt. 2, 1910, p. 124, pl. 59, figs. 29, 30.

⁵⁸ Jahrbuch der K. K. Geol. Reichsanstalt, Bd. 61, Nos. 3 and 4, 1911, p. 506, pl. 30, fig. 12.



impressed spiral grooves, these grooves underlain on the base and to some extent on the spire by vague, broad, distantly spaced spiral ridges; about 22 grooves between the periphery and the suture on the late whorls; aperture elongate, ovate, opening into a canal at each end; outer lip spirally ridged internally, the ridges ending in about eleven blunt nobs; inner lip with a strong blunt plait at about the middle, and another close to the anterior end of the aperture. Height 80.0 mm.; width 50.8 mm.; height of spire above body whorl about 30 mm.

Holotype: L.S.J.U. type collection, from Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; *paratypes* L.S.J.U. type collection and Nos. 2660, 2661 and 2662, Mus. Calif. Acad. Sci.; B. F. Hake collector; Isidro formation, lower Miocene.

Five other specimens of this species were examined from the type locality, and one from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon.

Apparently the nearest relative of this species is *C. henekeni tectiformis* Pilsbry⁵⁹, from the lower Miocene of Santo Domingo. From that species *C. heimi* appears to be distinguished by having a larger, heavier and somewhat narrower shell, with the nodes on the periphery a little broader and less sharp. From *C. tectum* Wood⁶⁰, a somewhat similar west American species of the genus, both the present species and its Caribbean analogue differ in bearing many fine spiral grooves between the periphery and the suture rather than the few (10-12) deeply impressed grooves separating broad, flat-topped spiral ridges that characterize *C. tectum*.

15. *Cypræa amandusi* Hertlein & E. K. Jordan, new species

Plate XVIII, figure 1; plate XIX, figures 1, 4, 5

Shell moderately large; resembles *C. mus* var. *bicornis* Sowerby; somewhat pear-shaped; dorsal margin very broadly rounded, in some specimens subsquare, margin cut by notch; dorsal surface of shell bears usually two nodes, one on each

⁵⁹ Proc. Acad. Nat. Sci. Phila., Vol. 73, pt. 2, 1921 (1922), p. 355, pl. 28, figs. 11, 12.

⁶⁰ Tryon, Man. Conch., Vol. 2, 1880, p. 201, pl. 63, fig. 330.

side of median dorsal line; posterior dorsal portion of shell noticeably depressed below the two nodes; highest part of shell anterior to nodes; some specimens slightly corrugated chiefly posteriorly; ventral portion of shell flattish; aperture curved and ornamented by about 20 to 22 teeth. Length 57.3 mm.; width 41 mm.; height 26.5 mm.

Syntypes: L.S.J.U. type collection, from Loc. 66 (L.S.J.U.), in **San Ignacio Arroyo, 8 kilometers southwest of San Ignacio, Lower California**; *paratypes* Nos. 2663 and 2664, Mus. Calif. Acad. Sci.; B. F. Hake collector; Isidro formation, lower Miocene.

Cypræa amandusi differs from *C. henckeni* Sowerby⁶¹ in possessing a much flatter shell and also in the presence of a depressed area in the dorsal posterior portion of the shell. From *C. mus* var. *bicornis* Sowerby⁶², *C. amandusi* differs in its larger size and in possessing a much flatter, less corrugated shell; in the latter strong nodes surmount ridges which run to the edge of the dorsal margin of the shell.

This species is named for Dr. Rudolph Amandus Philippi whose work added greatly to the knowledge of paleontology and conchology.

16. **Macron hartmanni** Hertlein & E. K. Jordan, new species

Plate XVIII, figure 2; plate XXI, figure 5

Shell of moderate size, very thick and solid, ovate in outline; spire elevated, the apex acute; whorls about five, moderately inflated, separated by deeply and broadly channeled sutures, the later whorls strongly shouldered at the summit; spiral sculpture consisting of a deep groove around the body whorl a little below the periphery, below which on the base are three or four narrow spiral grooves, and above which on main part of whorls are six to ten similar grooves that diminish in intensity anteriorly, the summit of the whorls without spiral sculpture; base concave below periphery, swelling toward the umbilical area into a large siphonal fasciole; umbilical area

⁶¹ See Maury, C., Bull. Amer. Paleo., Vol. 10, No. 42, 1925, p. 371, pl. 37, fig. 1.

⁶² See Tryon, Man. Conch., Vol. 7, 1885, p. 177, pl. 10, fig. 43.

subperforate; aperture ovate, produced into a short canal below, and also notched at the upper end, surrounded by thickened and callused lips; outer lip bearing a short blunt tooth at intersection with subperipheral spiral groove. Height 47 mm.; width 29 mm.

Holotype: L.S.J.U. type collection; *paratypes* L.S.J.U. type collection and Nos. 2665, 2666, 2667, 2668, 2669 and 2670, Mus. Calif. Acad. Sci., from Loc. 66 (L. S. J. U.), **San Ignacio Arroyo, 8 kilometers southwest of San Ignacio, Lower California**; Isidro formation, lower Miocene; B. F. Hake collector.

Eleven other specimens of this species were examined from the same locality.

This species is closely related to *M. merriami* Arnold⁶³, from the lower Miocene of southern California, but it seems to differ from that species in several particulars. The type of *M. merriami* is small, while the present species attains a much greater size, the largest specimen in the collection being 65 mm. in height. *M. merriami* lacks all spiral grooving anterior to the periphery, lacks the very strong shoulder at the summit of the whorls, lacks the deep concavity of the base just below the periphery, and is in general a more simple and less strongly marked shell. The pronounced development of many of these characters, however, including of course that of size, seems to a considerable extent to be a matter of age, and young examples of *M. hartmanni* differ little from *M. merriami*. *Macron hartmanni* has more numerous and much finer spiral grooves than either of the recent Lower California species, *M. kellettii* A. Adams⁶⁴ and *M. æthiops* Reeve⁶⁵.

17. *Polinices (Neverita) recluzianus* (Deshayes)

Natica recluziana DESHAYES, Mag. de Zool., Mollusca, 1841, pl. 37, "Mers de Californie."

Polinices (Neverita) recluziana (PETIT), ARNOLD, Mem. Calif. Sci., Vol. 3, 1903, p. 314, pl. 10, fig. 12.

Natica (Neverita) recluziana PETIT, CLARK, Univ. Cal. Pub. Geol., Vol. 11, No. 2, 1918, p. 167.

Neverita recluziana (DESHAYES), Dall, U. S. Nat. Mus., Bull. 112, 1921, p. 165.

⁶³ Proc. U. S. Nat. Mus., Vol. 32, 1907, p. 529, pl. 41, figs. 4, 4a.

⁶⁴ Tryon Man. Conch., Vol. 3, 1881, p. 214, pl. 82, fig. 477.

⁶⁵ Conch. Icon., Vol. 3, 1847, *Buccinum*, pl. 13, fig. 108.

Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; Isidro formation, lower Miocene.

This extremely variable species is recorded as extending in the west American Tertiary from the Oligocene to the recent. It is not attempted at this time to place in the synonymy the considerable number of alleged species, subspecies and varieties described by various authors as distinct from typical *P. reclusianus*, many of which fall without question within the range of variation of the single species. Several variants are represented in the present collection. According to Dall the range of *Polinices reclusianus* is at the present time from Crescent City, California, to the Tres Marias Islands and Chile.

18. ***Rapana imperialis*** Hertlein & E. K. Jordan, new species

Plate XX, figure 1

Shell large, strong, thick and heavy; spire low, broad, of about five whorls, the sides flattened; whorls strongly shouldered at a considerable distance below the summit; shoulder ornamented by a series of large, hollow, slightly curved horns, about nine such horns on the body whorl; periphery marked by a heavy, blunt spiral ridge, feebly nodose, the nodes roughly corresponding to the horns at the shoulder of the whorl; base concave, bearing about four strong, blunt, roughly squamose spiral ridges; no axial sculpture on spire or base other than rather pronounced incremental lines; a prominent siphonal fasciole encircling a wide open umbilicus; aperture large, opening anteriorly into a small recurved canal. Height 110 mm.; maximum width 105 mm.

Holotype: L.S.J.U. type collection, from Loc. 57 (L.S.J.U.), La Purisima cliffs, San Ramon River, Lower California; *paratype* No. 2671, Mus. Cali. Acad. Sci.; Isidro(?) formation, lower Miocene; E. Call Brown collector.

This magnificent shell is close to *Rapana vaquerosensis* Arnold⁶⁶ of the lowermost Miocene of upper California but

⁶⁶ Smithsonian. Misc. Coll., Vol. 50, 1908, p. 427, pl. 52, figs. 1a, 1b.

differs chiefly in being proportionately broader, with a less elevated spire, and in bearing fewer and much stronger horns on the shoulder of the whorls. These horns give the shell a strikingly coronate appearance.

19. ***Terebra burckhardti*** Hertlein & E. K. Jordan new species

Plate XXI, figure 6

Shell moderately slender, spire missing, four and one-half whorls present in type specimen; outline of whorls straight on sides; below suture each whorl possesses a somewhat convex projecting sutural band which is set off from remainder of whorl by a sharp, incised line; each whorl sculptured by about 18 longitudinal plications which run slightly oblique and offset slightly on crossing to the sutural band where they are coarser; on body whorl, plications bend slightly anteriorly at top of whorl and slightly posteriorly at base of whorl; canal unornamented. Length 25.5 mm.; width of body whorl 9.3 mm.

Holotype: L.S.J.U. type collection, from Loc. 66 (L.S.J.U.), in **San Ignacio Arroyo, 8 kilometers southwest of San Ignacio, Lower California**; *paratype* No. 2678, Mus. Calif. Acad. Sci.; Isidro formation, lower Miocene; B. F. Hake collector.

Terebra burckhardti differs from *T. variegata* Gray⁶⁷ in possessing a stronger projecting sutural band, stronger longitudinal plications, and sharper shouldered whorls. It is distinguished from *T. dislocata* Say, *T. aspera* Hinds and *T. acuaria* Toulou⁶⁸, by possessing coarser ribs, strong projecting collar and in lacking spiral ornament. From *T. gausapata herciderana* Spieker⁶⁹, *T. burckhardti* can be distinguished by the absence of the spiral sculpture which is so pronounced in

⁶⁷ See Tryon, Man. Conch., Vol. 7, 1885, p. 14, pl. 1, figs. 5, 7, 8; pl. 2, figs. 15, 19, 21; pl. 3, figs. 31, 37, 38.

⁶⁸ Jahrbuch d. K. K. Geol. Reichsanstalt, Bd. 61, Heft 3 & 4, 1911, p. 505, pl. 31, figs. 19a, b, c.

⁶⁹ Johns Hopkins Univ. Studies in Geol., No. 3, 1922, p. 35, pl. 1, fig. 1.

Spieker's subspecies. Furthermore the present species possesses a more slender shell than does Spieker's subspecies. *Terebra burckhardti* differs from *T. (Myurella) coleri* Engerand & Urbina⁷⁰ in lacking spiral sculpture on the whorls, in the absence of plaits on the columella and apparently in possessing more sharply shouldered whorls than *T. coleri*.

This species is named for Dr. Carlos Burckhardt in recognition of his excellent contributions to the knowledge of the paleontology and stratigraphy of Mexico.

20. *Thais wittichi* Hertlein & E. K. Jordan, new species

Plate XVIII, figure 3

Shell rather large, thick and solid, moderately elongate; spire moderately elevated, of six slightly inflated whorls separated by fairly well defined sutures; whorls vaguely shouldered at some distance anterior to the summit, crossed by six to eight strong varices which are somewhat produced at the shoulder; also sculptured between the suture by 10 to 20 low, unequal spiral ridges separated by narrowly impressed grooves, the spiral sculpture continuous across the varices; base rather long, ornamented by continuations of the varices and by spiral sculpture similar to that of the earlier whorls; umbilicus narrow but plainly open; a prominent siphonal fasciole; aperture broadly ovate, produced anteriorly into a rather long, narrow, straight canal, which in old specimens tends to be partially covered over; inner lip rather heavily callused; outer lip thickened and bearing seven to nine strong knobs within.

Holotype: L.S.J.U. type collection; *paratypes* L.S.J.U. type collection and Nos. 2672, 2673, 2674, 2675, 2676 and 2677, Mus. Calif. Acad. Sci., from Loc. 66 (L.S.J.U.), **Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California**; B. F. Hake collector; Isidro formation, lower Miocene.

Fifteen other specimens of this species were examined from the same locality where it is apparently abundant.

⁷⁰ Bol. Soc. Geol. Mex., T. 6, 1910, p. 120, pl. 59, figs. 35, 36.

This fine species is apparently totally different from any of the genus known from the Miocene of western North America, from the Peruvian region, or from the Caribbean region.

This species is named for Dr. Ernest Wittich whose work has added to the knowledge of the geology of Lower California.

21. *Turritella bösei* Hertlein & E. K. Jordan, new species

Plate XXI, figures 1, 2

Shell large, long; early whorls similar to *T. ocoyana* but later with a strong, projecting carina at point of greatest diameter; whorls slightly concave above carina; point of greatest concavity occurs at about one-third the length of whorl from top of whorl; whorls ornamented above carina by about 6 or 7 strong, subequally spaced lines; below point of greatest diameter two spiral lines ornament whorl; spiral lines increase in prominence in later whorls where they are crossed by oblique lines of growth; base of body whorl ornamented by 7 to 8 spiral lines. Length (earliest whorls missing) 143 mm.; greatest width of body whorl 38 mm.

Syntypes: L.S.J.U. type collection, from Loc. 66 (L.S.J.U.), in **San Ignacio Arroyo, 8 kilometers southwest of San Ignacio, Lower California**; *paratypes* Nos. 2679, 2680 and 2681, Mus. Calif. Acad. Sci.; B. F. Hake collector; Isidro formation, lower Miocene.

Turritella bösei differs from *T. ocoyana* Conrad⁷¹ to which it is closely related, in possessing a projecting carina on most of the whorls at the point of greatest diameter; also the whorls above the carina are slightly concave and ornamented by stronger spiral sculpture. From *T. supraconcava freadi* Hodson⁷², *T. bösei* differs in possessing somewhat coarser and

⁷¹ Pac. R. R. Rept., Vol. 5, 1857, p. 329, pl. 8, figs. 73, 73a, 73b.

⁷² Bull. Amer. Paleol., Vol. 11, No. 45, 1926, p. 13, pl. 5, figs. 1, 3; pl. 6, figs. 2, 5; pl. 7, figs. 1, 6, 7; pl. 9, fig. 7; pl. 28, fig. 6. (= *T. supraconcava freadi* Hodson. *Tl. robusta* Grzybowski = *T. supraconcava* HANNA & ISRAELSKY, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 2, 1925, p. 59. Not *T. robusta* GABB, Paleo. Calif. Vol. 1, 1864, p. 135, pl. 21, fig. 94, from Cretaceous of California.)

less numerous spiral lines. Furthermore the whorls are more convex above the carina in *T. bösei* than in Hodson's subspecies and the whorls in the present species slope much more abruptly from the carina anteriorly to the suture. The carina in *T. bösei* does not project so far and it is not so sharp as *T. s. freadi*.

From *T. subgrundifera* Dall⁷³, *T. bösei* differs in its larger size, in possessing heavier spiral lines in the later whorls, and in that the whorls are slightly concave above the carina. *T. bösei* has two spiral lines below the carina which are separated by a wider interspace and both are nearer the suture than are the corresponding lines in Dall's species.

This species is named for Dr. Emil Böse in recognition of his contributions to the geology and paleontology of Mexico.

22. *Turritella wittichi* Hertlein & E. K. Jordan, new species

Plate XXI, figures 3, 4

Shell long, fairly slender; 7 subconvex whorls present, several early whorls missing in type specimen; from suture whorls slope outward to greatest diameter which occurs about one-third the length of whorl from base, point of greatest diameter marked by a fairly strong spiral rib below which whorls slope rather abruptly to suture; above rib marking greatest diameter are 4 to 6 well defined equidistantly spaced, spiral ribs, in some whorls a tiny midrib occurs between the strong carinal rib and first rib above; immediately below point of greatest diameter an interval of space occurs below which three equidistantly spaced fine spiral lines occur; on base of body whorl the lowest of these lines marks a subangular shoulder, below which the base is ornamented by several fine spiral lines. Body whorl also ornamented by lines of growth which cross the spiral sculpture obliquely; in early whorls growth lines are very slight or lacking. Height 86 mm.; greatest diameter of body whorl 24 mm.

⁷³ Trans. Wag. Inst. Sci., Vol. 3, pt. 2, 1892, p. 313, pl. 22, fig. 23.

Holotype: L.S.J.U. type collection, from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California, on the trail from Arroyo Mesquital to La Purisima; *paratypes* L.S.J.U. type collection and Nos. 2682, 2683 and 2684, Mus. Calif. Acad. Sci., from Loc. 59 (L.S.J.U.); E. Call Brown collector; Isidro(?) formation, lower Miocene.

Turritella wittichi in its earlier whorls resembles *T. ocoyana* Conrad, but it differs in that the point of greatest diameter occurs at about one-third the length of whorl from base while in *T. ocoyana*, the greatest width of whorl is usually near the base.

Turritella wittichi differs from *T. nelsoni* var. *rotundata* Grzybowski⁷⁴ in lacking the numerous fine secondary spiral ribs, and in that the base of the whorls slope more abruptly to the suture, furthermore *T. nelsoni* var. *rotundata* possesses four lines below the carina while only three are present in *T. wittichi*. Apparently the early whorls are more subangular in *T. wittichi* than in *T. nelsoni* var. *rotundata*.

From *T. venezuelana* Hodson⁷⁵, *T. wittichi* differs in possessing more numerous and much fainter spiral ribs, furthermore the whorls bear three fine spiral lines anterior to point of greatest diameter, while in Hodson's species but one strong spiral rib is present. *T. wittichi* differs from *T. tristis* Brown & Pilsbry⁷⁶ in possessing more numerous spiral ribs, the point of greatest diameter occurs about one-third the length of whorl from base, and the base of whorls is ornamented by three fine spiral lines. *T. wittichi* can be distinguished from *T. infracarinata* Grzybowski⁷⁷ by the finer ribs in the present species, and in that the point of greatest diameter is about one-third the length of whorl from base, and three fine lines orna-

⁷⁴ Neues Jahrbuch für Miner. Geol. u. Paleo. Beil. Bd. No. 12, 1899, p. 643, pl. 20, fig. 6; see also Spicker, Johns Hopkins University Studies in Geol., No. 3, 1922, p. 77, pl. 3, fig. 7.

⁷⁵ Bull. Amer. Paleo., Vol. 11, No. 45, 1926, p. 32, pl. 21, figs. 4, 8; pl. 22, figs. 1, 6.

⁷⁶ Proc. Acad. Nat. Sci. Phila., Vol. 63, 1911, p. 358.

⁷⁷ Neues Jahrbuch für Miner. Geol. u. Paleo. Beil. Bd. 12, 1899, p. 643, pl. 20, fig. 5; see also Spicker, Johns Hopkins Studies in Geol., No. 3, 1922, p. 79, pl. 3, figs. 9 and 10.

ment the anterior part of whorl between point of greatest diameter and suture.

T. wittichi differs from *T. gatuncensis* Conrad⁷⁸ in its larger size, in possessing differently shaped whorls, fainter ribbing, and in possessing only one strong rib on the wider part of the whorls.

This species is named for Dr. Ernest Wittich in recognition of his contributions to the knowledge of the geology of Lower California.

⁷⁸ Pac. R. R. Rept., Vol. 6, p. 72, pl. 5, fig. 20; also Dall, Trans. Wag. Inst., Vol. 3, pt. 2, 1892, p. 310, pl. 17, fig. 10.



Plate 17

- Fig. 1. *Glycymeris swartsi* Hertlein & E. K. Jordan, new species; natural size; paratype, left valve, No. 2659 (C.A.S. type coll.), from Loc. 60 (L.S.J.U.), west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California; Isidro (?) formation, lower Miocene; p. 620.
- Fig. 2. *Glycymeris swartsi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 620.
- Fig. 3. *Ostrea angermanni* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California. Isidro (?) formation, lower Miocene; p. 621.
- Fig. 4. *Chione richthofeni* Hertlein & E. K. Jordan, new species; natural size; paratype, (L.S.J.U. type coll.), from Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California. Isidro formation, lower Miocene; p. 619.
- Fig. 5. *Isurus hastalis* Agassiz; natural size; plesiotype, (C.A.S. type coll.), from Loc. 958 (C.A.S.), east side of Turtle Bay, about one half mile northeast of prominent yellow mesa or monadnock, Turtle Bay, Lower California; lower Miocene; p. 609.
- Fig. 6. *Ostrea angermanni* Hertlein & E. K. Jordan, new species; natural size; same specimen as fig. 3; p. 621.
- Fig. 7. *Chione richthofeni* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 4; p. 619.
- Fig. 8. *Chione richthofeni* Hertlein & E. K. Jordan, new species; natural size; same specimen as fig. 7; p. 619.
- Fig. 9. *Ostrea freudenbergi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 3; p. 622.

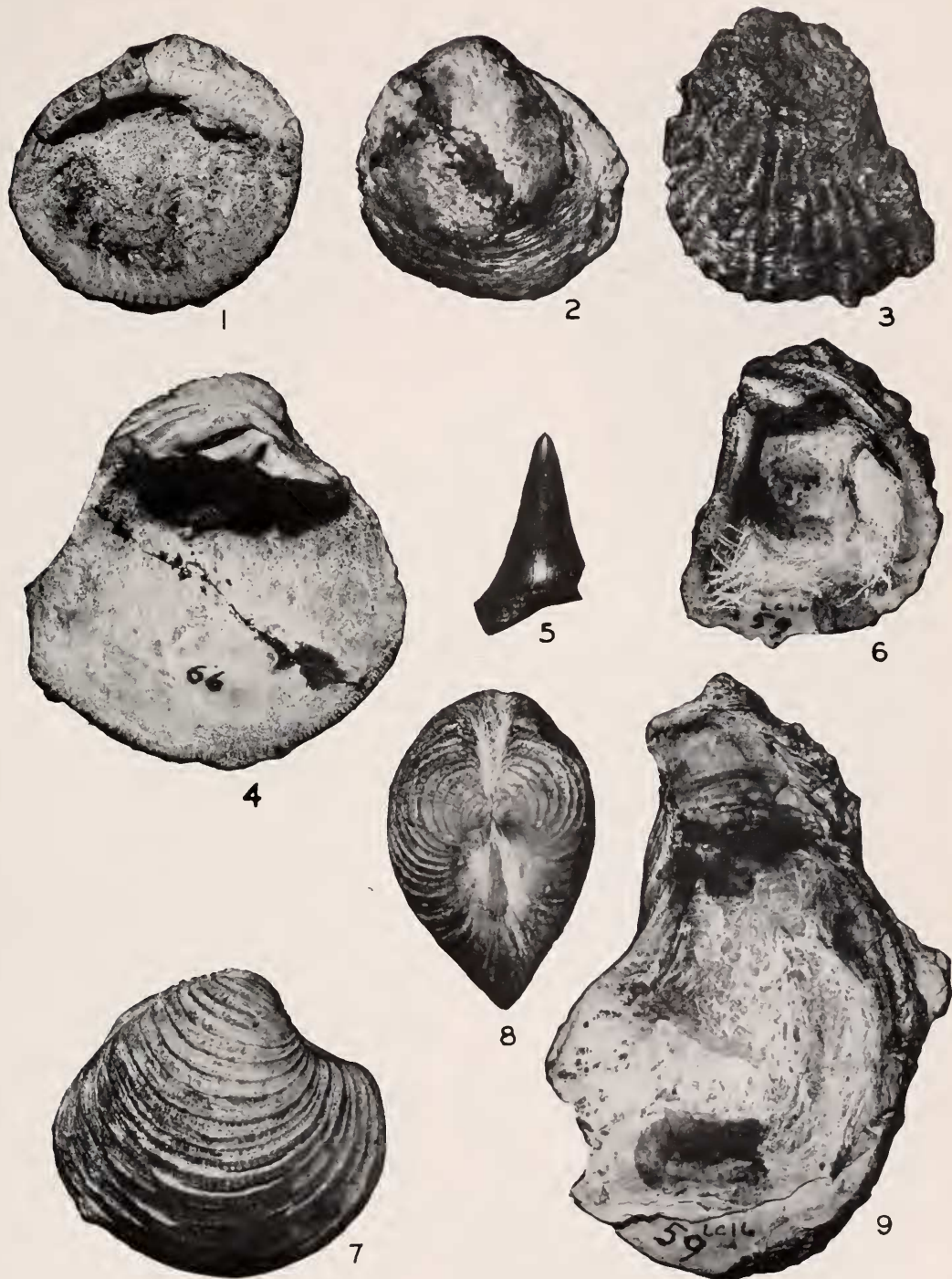


Plate 18

- Fig. 1. *Cypraea amandusi* Hertlein & E. K. Jordan, new species; natural size; syntype, (L.S.J.U. type coll.), from Loc. 66 (L.S.J.U.), San Ignacio Arroyo, 8 kilometers southwest of San Ignacio, Lower California. Isidro formation, lower Miocene; p. 628.
- Fig. 2. *Macron hartmanni* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 629.
- Fig. 3. *Thais wittichi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 633.
- Fig. 4. *Ostrea freudenbergi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), same specimen as Pl. 17, fig. 9; p. 622.
- Fig. 5. *Cymia heimi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 627.



Plate 19

- Fig. 1. *Cypræa amandusi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from Loc. 66 (L.S.J.U.), San Ignacio Arroyo, 8 kilometers southwest of San Ignacio, Lower California. Isidro formation, lower Miocene. Same specimen as Pl. 18, fig. 1; p. 628.
- Fig. 2. *Turritella ocoyana* Conrad; natural size; plesiotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 608.
- Fig. 3. *Ostrea* sp.; natural size; plesiotype, left valve, (L.S.J.U. type coll.), from Loc. 57 (L.S.J.U.), La Purisima cliffs, San Ramon River, Lower California. Isidro formation, lower Miocene; p. 623.
- Fig. 4. *Cypræa amandusi* Hertlein & E. K. Jordan, new species; natural size; paratype, No. 2663 (C.A.S. type coll.), from same locality as fig. 1; p. 628.
- Fig. 5. *Cypræa amandusi* Hertlein & E. K. Jordan, new species; natural size; paratype, No. 2664 (C.A.S. type coll.), from same locality as fig. 1; p. 628.
- Fig. 6. *Ostrea* sp.; natural size; plesiotype, (L.S.J.U. type coll.). Same specimen as fig. 3; p. 623.

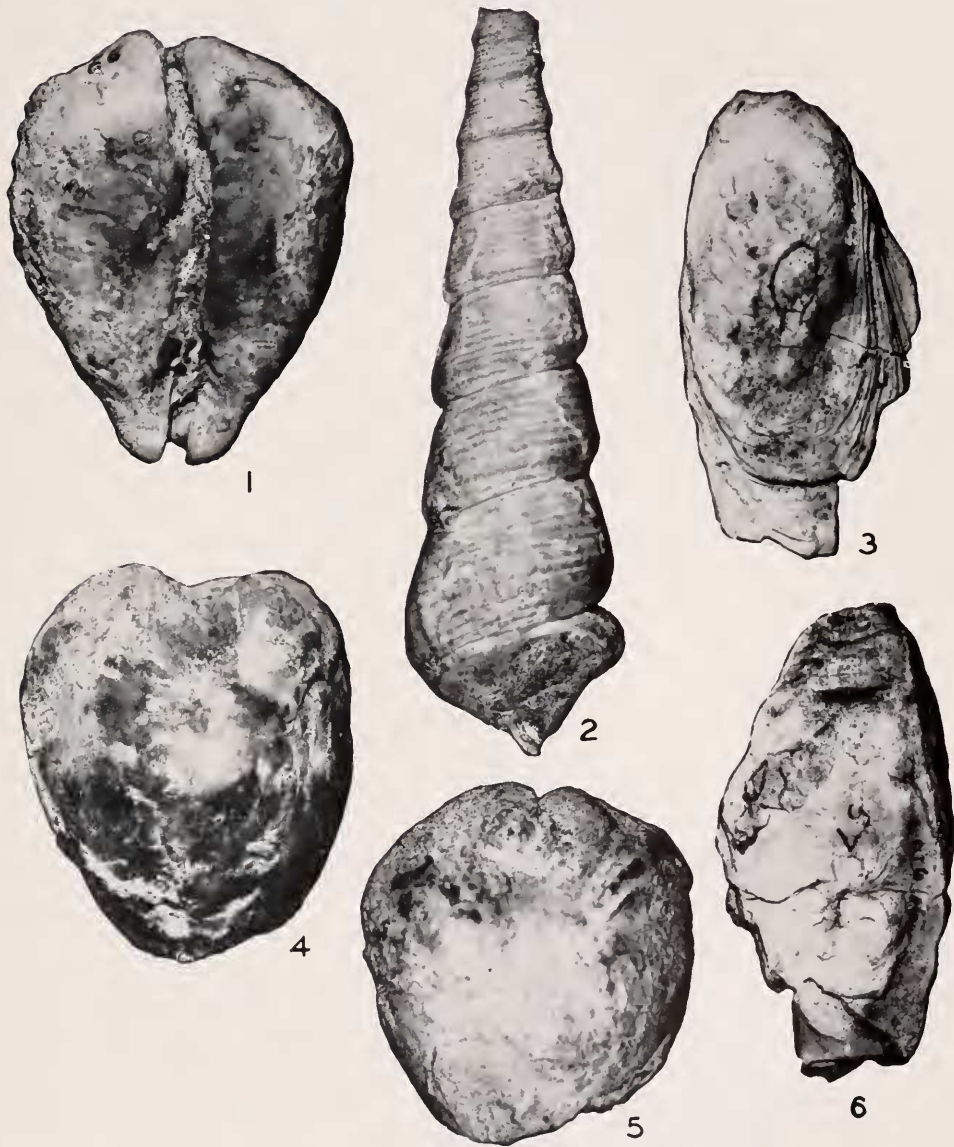


Plate 20

- Fig. 1. *Rafana imperialis* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from Loc. 57 (L.S.J.U.), La Purisima cliffs, San Ramon River, Lower California. Isidro (?) formation, lower Miocene; p. 631.
- Fig. 2. *Sanguinolaria toulai* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California. Isidro formation, lower Miocene; p. 625.

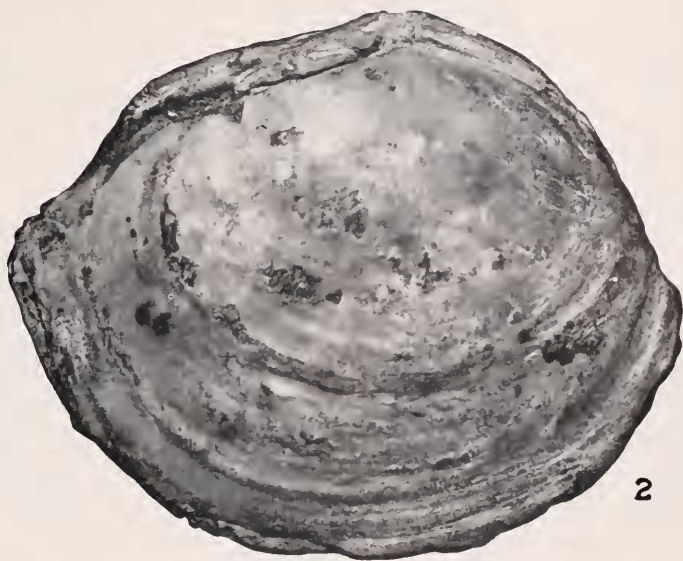


Plate 21

- Fig. 1. *Turritella bösei* Hertlein & E. K. Jordan, new species; natural size; syntype, (L.S.J.U. type coll.), from Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California. Isidro formation, lower Miocene; p. 634.
- Fig. 2. *Turritella bösei* Hertlein & E. K. Jordan, new species; natural size; syntype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 634.
- Fig. 3. *Turritella wittichi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California; Isidro (?) formation, lower Miocene; p. 635.
- Fig. 4. *Turritella wittichi* Hertlein & E. K. Jordan, new species; natural size; paratype, No. 2682 (C.A.S. type coll.), from same locality as fig. 3; p. 635.
- Fig. 5. *Macron hartmanni* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; same specimen as Pl. 18, fig. 2; p. 629.
- Fig. 6. *Terebra burckhardti* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 632.
- Fig. 7. *Crassispira starri* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 626.
- Fig. 8. *Calliostoma hannibali* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 626.
- Fig. 9. *Calliostoma hannibali* Hertlein & E. K. Jordan, new species; natural size; view of base; holotype, (L.S.J.U. type coll.), same specimen as fig. 8; p. 626.
- Fig. 10. *Turritella* sp.; natural size; plesiotype, (L.S.J.U. type coll.), from Loc. 60 (L.S.J.U.), west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California; lower Miocene; p. 608.

